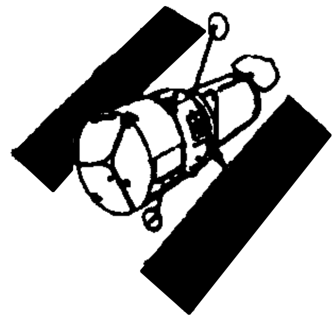

HST VISION 2000 CONCEPT

for the

PROJECT REFERENCE DATA MANAGEMENT SYSTEM

Prepared by:

Michael Bielefeld, ST ScI
Ginny Brown, Loral
Wayne Burdick, LMSC
David Fish, Loral
Martin Gakenheimer, ATSC
Charlie Hicks, ATSC
Ron Holland, Recorder, CSC
Gabriel Menchaca, ST ScI
Brian Rehm, Code 512
Dennis Sasaki, LTOC
Greg Smiley, LTOC
Maria So, Chair, Code 441
Stan Sobieski, Facilitator, Swales

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The Project Reference Data Management System

1.0 INTRODUCTION

The business of the HST ground and flight systems is to support the collection of astronomical data. The Project Reference Data (PRD) system is merely one spoke in a wheel which allows this data collection to occur. But the fact remains, it is a spoke, and as such, the PRD must support and be supported by many HST processes and the people who make it all work. In the case of the HST system, the processes and people who support HST are highly distributed, with highly specialized skills. No one person (or organization for that matter) is responsible for the operation and maintenance of HST nor its data. Any information or data management system which is proposed for the HST environment must address the distributed nature of the work and the people, while supporting the central goal of the accurate and efficient collection of astronomical data.

One of the requirements of the Vision 2000 Operations Concept is to give control of what is currently referred to as the Project Database (PDB) to the primary users or maintainers of the data in order to prevent the costly time delays in making small changes. By distributing access and control of the data, those directly responsible for its maintenance will be required to assume the following responsibilities:

- data management and version control
- data and documentation distribution and coordination
- data validation, testing and certification
- data integrity and security
- support to sustaining engineering

The data being shared can be anything from HST spacecraft command definitions to data describing the versions of software being used in the operational ground software systems. As a starting point, all of the data which is currently part of the HST PDB is considered reference data. This data is required by the database driven ground software systems and in most cases contains one or more dependencies with other reference data. For example, the HST Spacecraft Command Definition data (CMDS.DAT) is used and referenced in the Planning Command Pool command groups (PLCP.DAT). A dependency therefore exists between these two types of data, and traditionally they were both made part of the PDB so that any changes made would remain synchronized. The synchronization and dependency issues have not vanished in the concept presented here but changes which perturb these dependencies or relationships will occur less frequently. Accommodating these loosely coupled changes is of tantamount importance in designing the reference data architecture.

Central to this new concept is the physical distribution of the data. But to assume that all problems are solved with the distribution of the data is to ignore the primary reason the HST PDB was created in the first place -robust coordination and control of the data. The key components of the PRD system Architecture allow for the distributed management of the reference data, while maintaining its accuracy as well as its accessibility to users regardless of their physical location.

1.1 Objectives

Vision 2000 is one of those rare opportunities to make radical improvements in the operational efficiency of a complex, evolved system by the use of the latest technologies and by correcting latent design deficiencies. The Vision 2000 concept for the HST operational system is organized into four functional centers or product areas, namely the Control Center System (CCS), the Planning & Scheduling System (P&S), the Science Data Process (and archiving) system (SDP), and the Flight Computer Systems[1] (FCS), which encompasses the hardware and software associated with the DF224/COP, the payload computer, and data interface subsystems. This white paper addresses how the historically separate HST entity, the Project Data Base (PDB), might meld its functions into these centers in such a way as to radically improve the overall system. They revolve around the central issues of:

- accuracy and timeliness of updates
- accessibility of data
- friendliness of the support systems and technologies

As the four product areas become defined, especially in their architectures and data structuring, the elements presented in this white paper will eventually be subsumed under the direction of the Product Development Teams (PDT for these centers. This paper will attempt to present accumulated expertise to help the new product areas of Vision 2000 avoid the past mistakes and improve future operations. It also introduces global issues beyond the scope of the individual PDTs which must be addressed from a system's point-of-view.

A goal of V2000 is to assure that the manipulation of data and the data-change process be correct and innocuous to the user rather than obstacles to be overcome. This goal, we believe, is achievable through the use of today's advances in network communication and computer power coupled with the organizational theme that the party closest to the data should be given the responsibility to see that the data is correct and the data-change is timely. This theme, known as decentralization, should be followed to the granularity which makes sense for efficient HST operations. Along with decentralized control of the data come responsibilities for:

- data management and version control
- data and documentation distribution and coordination
- data validation, testing and certification
- data integrity and security
- support to sustaining engineering

This paper has attempted to bring together HST's collective wisdom about the many aspects of organizing, tracking, disseminating, testing, certifying, and maintaining reference data in the present system and to suggest approaches for the future.

1.2 Scope

The Vision 2000 PDB has been renamed Project Reference Data (PRD) system - to avoid ambiguity in the V2000 documentation - and it is defined not as an independent data entity controlled and maintained by a central organization, but rather a class of data which is shared within and across the various ground system elements according to prescribed protocols. This data clearly includes the data elements of the current PDB, its corresponding metadata (tracking information, control information, ICD information, etc.) and also similar HST reference data which historically grew up outside of the PDB.

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[1] Currently, the fourth product area is limited to the COP migration. But any consideration of major data base implementation and management changes must include all flight computer systems requiring reference data and the product area scope has consequently been expanded for completeness.

The PRD system provides support services which are maintained locally for access, distribution, and status. The vision is that the PRD system is friendly to the user and transparent as to its form or to the place where it is maintained. The architecture for the PRD system requires some global aspects, such as standards and structures, to be applicable Project-wide and not are undertaken by the individual PDT's. These include mechanisms and procedures to assure coordinated data integrity and synchronized installation across HST subsystems.

The basic source data and its corresponding metadata is within the scope of this paper, but the secondary operational forms thereof are not. Nor does this paper address a transition plan to get from the present to the Vision. The 1997 Servicing Mission will be supported but the form of that support is not addressed herein either. Three appendices are included showing present PDB file interdependencies and a preliminary cut at how the PDB/PRD might be decentralized to local owners. The final allocations will depend on the final architecture of the VISION 2000 system.

1.3 Reference

The subject data of this paper and much of its metadata can be found by starting at the following Internet reference.

http://samvax.stsci.edu/www_root/sogspdb/pdb_home.html

2.0 FUNCTIONAL DESCRIPTION

The HST PRD Management System must be accessible, easy to use, accurate and timely. These adjectives are synonymous with the goals of the PRD system concept. These goals are similar to those of any information system supporting any number of business operations throughout the world. Data is required to run the business. Data is a critical resource, therefore efficient business processes, supported by the proper enabling technologies, are key to the success of the business.

This section presents a conceptual description of a system which meets the goals and highlights how it might be organized. All ground/flight system product areas described in this paper (CCS, P&SS, SDP, FCS) will utilize the same Project Reference Data concepts and general architecture. Therefore, the following concept , functionality and description are equally valid for all elements.

2.1 Local Data Management

The PRD concept distributes all of the HST reference data (PRD) to a specific 'controlling' system element (CCS, P&S, SDP, FCS) and therefore to the people, processes and systems most familiar with the data. In most cases, these are also the people, processes and systems most affected by changes in the data (users of the data). It has been the experience of HST that those responsible for what has been historically the PRD, know best how to create it, modify it and test it. The weakness has been in the activities required to support packaging and distribution of the final products, synchronization of changes across the various systems, as well as the identification of impacts which ripple through dependent data. The Appendices provide information which identifies where data controlled by one system element, may affect a system element which uses the data in a passive capacity. The majority of the current PDB (PRD) does not cross system functional boundaries, and therefore, to some extent, facilitates the concept of local data management. The data which is required in more than one system is manageable, and is further addressed later.

The PRD concept treats local and cross-system data differently. It does not attempt to force a single data management system or philosophy on all data, and in this way provides flexibility. Potential system efficiencies are not overshadowed by a need to conform to and support a data management system which neither excels at managing local data nor cross-system (global) data. An efficient approach can be formulated for each independently, as long as the need to support system wide/global functions and processes is recognized.

2.2 System Architecture

Figure 1 is a graphical representation of the architecture designed to support the VISION 2000 re-engineering effort in the area of Project Reference Data. Although the exact number of hardware components is not yet know, each of the four product areas (e.g., CCS, P&SS, SDP and FCS[2]) is replicated to accommodate separately development and operational activities. These two 'strings' must match identically, with respect to capabilities provided in the operational version. The reference data "maintenance" is presumed to be accomplished in the development string before being issued in the form of an Operational Data Base (ODB) for use in the operational string. As the figure shows, the development systems are primarily connected by a development LAN while the operational systems are similarly connected by a separate, secure LAN based on the use of either Nascom connectivity or "security firewalls". To prevent operational interruptions and reduce risk, data from the development LAN cannot enter the operational LAN except through the secure firewall.

The development, maintenance and test systems are used to create, modify, test, certify, collect and distribute the HST Reference Data. Only when the data is deemed 'certified' is it securely delivered to the operational strings. Log files and other operational information may be generated by the application software during execution and needs to be saved by the system, but this data is typically not classified as reference data which has a more static nature (i.e., it is not typically modified during 'live' operations), and is therefore not addressed by this architecture. Localized databases with their own tool kits will be designed around each ground system element's unique requirements while maintaining compatibility with the PRD system concept.

2.3 System Services

To facilitate standardized or logical access to HST ground system reference data and metadata, two 'coordination services' are proposed; Data Archive Service Coordination and Configuration Management (CM) Service Coordination. These services are supported by a 'Service Coordinator' which may entail people, H/W and S/W technologies, or some combination thereof. The specifics of these services is currently undefined, therefore, the amount of manual intervention required and therefore the number of people supporting these services is also unknown. The goal of the PRD concept is to completely automate these services via system servers (computing platforms). The system providing the service will be referred to as a 'Service Coordinator.' The Data Archive Service Coordinator operates with the reference data itself, while the CM Service Coordinator operates with the reference metadata.

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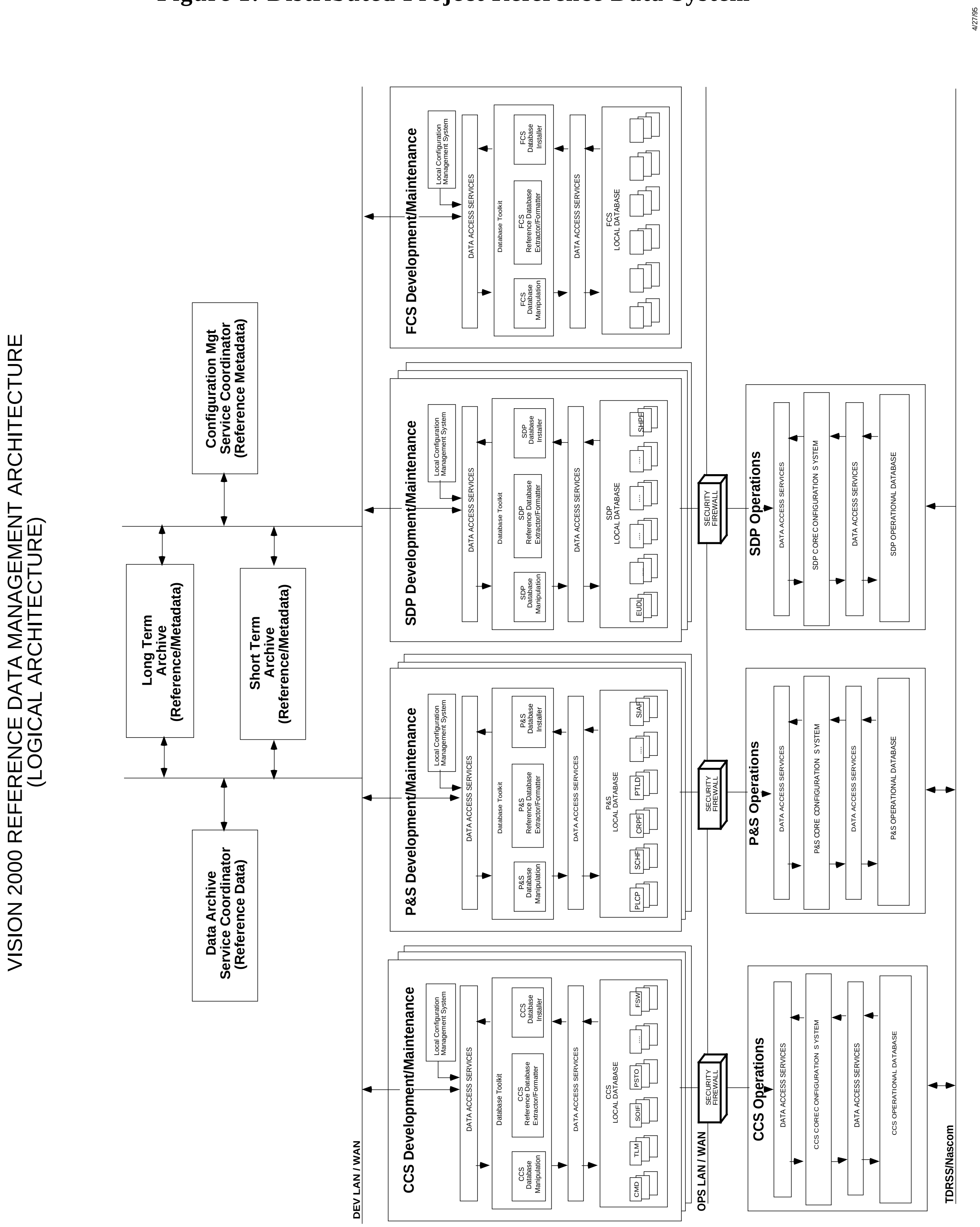
[2] The operational version of the FCS is, of course, on-board HST. The ground development and maintenance is accomplished using a collection of facilities such as the ESTIF, DSTIF, VEST, etc.

Figure 1: Distributed Project Reference Data System



Before moving on to describe the services in more detail, it should be emphasized that the PRD system manages two types of data : reference data and metadata. The reference data is what is physically installed into the ground software systems and has been traditionally known as the PDB, while the metadata is data which describes or characterizes the reference data (tracking data, testing status, ICDs, data format descriptions, etc.).

The two server systems (CM, Data Archive) provide the common coordination point for finding and accessing HST reference data and metadata, whether it be archived versions of reference data, configuration management information or some other reference metadata. These coordinators or servers provide a logically centralized "view" of the reference data and metadata. A good model to use when thinking about the role of these coordinators is the World Wide Web. The coordinators act like 'home pages'. Although it is critical to point out that the interaction with the data servers(coordinators) is not limited to human/computer interaction. Other computer systems/processes will have the ability to query the servers for data directly without human intervention.

The coordinators provide seemingly centralized access to data which may be distributed across one to many computer systems. The Data Archive Service Coordinator, for example, will lead a user or software process to a local database system, short or long term data archive, or it will retrieve data from a distributed data repository and make it available. The location of the data and the data access methods are transparent to the user/process. The coordinators are tasked with resolving data locations and providing the support required to either help a user navigate to where the data is located, or make a remote data request (archiver or other distributed data resource), so that a user or process receives the data it has requested, regardless of its actual location.

The exact data architecture which the Coordinators will support will be dependent upon the requirements and design of each HST ground system product area. The only requirements are that the user/process has a central place to go in order to begin the navigation/query process, and that the ground system elements make their reference data available either in their local database or via the archive services. The Coordinators will then help users/processes get to or retrieve the information they desire regardless of its location, while allowing each ground system to manage the data in a way most effective for their system.

3.0 OPERATIONAL CONCEPT

3.1 User Categories

Users can be thought of as falling into one of two categories, active and passive. Active users are those who update and maintain reference data (owners), and in most cases use it. Passive users are those who retrieve the data to use but do not have the need nor the privileges required to change it. It is the responsibility of the active user of data to alert all passive users of the data via electronic mail when a change will be made and certified. Passive users can then retrieve or view the data using available tool kits.

3.2 Data Classes and Dependencies

The PRD system has been divided into four classes based on ownership and usage of the data. Differences among classes provide a foundation for managing the data.

Class I - The reference data is required by both active and passive users. The owner is the subsystem where the data is maintained; users are part of that system and may be members of other subsystems.

Class II - The owner of the reference data is not a direct user.

Class III - The active user is the only user of the data, implying no interdependencies. The owner in this case is the subsystem, (e.g., global parameters for CCS)

Class IV - The reference data is only used personally by a single user. This data can be operational (e.g., PSTOL procs) or test data which is used in the development process.

For Classes I and II, coordination between development groups must occur so the change will be understood and implementation can occur in a timely and simultaneous manner. For Class III data, coordination only must occur among users and developers within the subsystem. Should an individual owner leave the project, ownership of the data must be reassigned. In the case of Class IV and possibly Class III data, the data may not ever be utilized by any other users. It should be archived on a short term basis and ultimately deleted as a measure to prevent unchecked growth of reference data.

3.3 Nominal Operations

Each development/maintenance ground system element controls and manages a local data base which contains operational, test and development database information. Within each ground system or product area exists a tool kit which allows the 'operators' of that system to maintain and modify the database information. The tool kits also facilitate the extraction, formatting and transfer of database information into or out of the controlling system to one of the other HST ground system elements (i.e. Command database from CCS to P&SS). The extraction, formatting and distribution processes allow for the efficient exchange and translation of data from one format to another. The data is nominally transferred as part of a transaction or logical unit.

When a database or portion thereof is required in an operational string, the data is passed through a network firewall. In preparation for operational use, the data will be formatted into files for optimal use by the operational string. The operational system handles its installation and distribution once inside the secure operations facility (core). The core facilities are those directly supporting live-HST operations.

3.4 Data Location, Storage and Access

The current PDB data will form the basis of the PRD system. It will be distributed to the various PDTs as initially determined the PRD system Working Group, thereby assigning ownership of the data. This assignment may be subject to change as the subsystems are designed based on discussions among PDTs. As designs progress, the PDTs may add new data into the reference data pool or some portion of the PDB data may become obsolete and therefore be deleted. The data will be stored within the subsystem based on a number of factors:

- Recommendations of the PRD system Working Group based on preliminary considerations of system wide compatibility, accessibility, and accountability.
- Design of each subsystem and the intended use of its RD.
- Ease of access, change, and distribution.

Each subsystem will have the capability to maintain multiple versions for operations and development. As versions are no longer needed, they will be stored in the archive, and so be available when required for analysis. The PRD system may be accessed by anyone in the HST community via the tool kits available within the subsystem or those provided through the archive coordinator. The archive coordinator will allow the user to access local subsystem data to the long or short term archive. The physical location of the data and data access methods will be transparent to the user.

3.5 Change Coordination and Data Synchronization

The PRD system is being designed based on localized ownership and control of reference data. Nonetheless coordination between ground system elements is required for any Class Updates or for a centralized event, like a flight software update. Such updates require multiple ground system elements to be in synch for the RD update. Coordination with additional elements, for example, spacecraft hardware and software developers, may be required in some cases. In each case however, the owner of the update, the active user, should coordinate scheduling, testing, and implementation over the wide area network.

Data synchronization will be achieved as before when the ground and flight system elements have coordinated command and telemetry changes. The changes to format, design and output definition must continue to be mandated in a timely and efficient order for any data entity to be valid. The PRD system design will accommodate this requirement easily as all elements are relegated to either a global or a local interface. Reference data sets supporting development and real-time flight operations can be packetized and interchanged as the need dictates.

3.6 Data Integrity, Validation, Testing and Certification

Generally an engineering memorandum (EM) provides the level of detail required for configuring the Flight Software (FSW) assembly code, logical memory unit configuration and/or ground system changes needed. The EM identifies the various Configuration Change Requests (CCRs) and Software Change Requests (SCRs) that have been submitted in order to configure the Flight Software as well provisions for future enhancements to FSW and Ground systems operation. It is the responsibility of the originator or systems personnel to be knowledgeable of any change being implemented or proposed to the flight software (FSW) or to ground systems elements and to keep good records and history files. Once data base changes are recognized as being validated via one of more of the various test sources, then the desired change is moved from the Development Data Base (DDB) of the test environment to the Operational Data Base (ODB) of the real-time system.

Data integrity must be confirmed prior to implementation and certification to meet the design requirements by the system developer and experts with operational experience. This process includes analysis based on simulator and ground system testing. The degree of testing must be consistent with NASA standards, be proportional to the risk involved and to a lesser degree based on the availability of resources and time required to utilize those resources. The degree of testing should never be determined based on the availability of personnel. Final certification approval will be determined by the active user.

The PRD system class reference data sets will also require testing and certification prior to release, but as mentioned previously, due to the relational attributes between the various elements the labor intensive task will be greatly simplified. Class data which is generated and initially validated externally to the HST system, can now be validated real-time internally across common interfaces provided by the PRD. Testing and certification process will continue to segmented until the aspects of whether a regression scenario is required for each change to the system or rather a functional verification would suffice. These are questions best left to the Test Development proposals.

3.7 System Standards

System wide standards will be established in the development phase of the PRD system to assure system integrity and consistent user accessibility. All active users and/or representatives of each element are responsible for assuring the completion of all phases of the update process and assuring the configuration management service coordinator is properly updated with the appropriate metadata. Updates to the data archive service coordinator and any documentation on the wide area network are also the responsibility of active user and must conform to the system wide standards.

4.0 MISSION OPERATIONS SUPPORT

This section describes PRD system applicability in support of some typical HST mission scenarios.

4.1 Science Targets of Opportunity

The PRD can accommodate quick changes that might be necessary for scheduling targets of opportunity, allows for notification of other ground system elements, and provides a permanent record of the changes made with its data archive service coordinator.

4.2 HST Ground and Flight System Anomalies

Most often operations will proceed nominally without a flaw. However, there are those periods when there are deviations from the norm caused by any of the below referenced situations: a) subsystem equipment failures (Hardware failures) b) Flight Software Installation c) Ground system Operation d) Operation planning (Targets of Opportunity). The PRD provides for quick update capability which will be particularly applicable for HST anomalies. The first few steps following any HST Safing event is to assure the vehicle is safe and then to analyze the anomaly. Any assumptions can be tested on one or more of the HST simulators. In the testing phase the necessary PRD changes can be made and tested in the development area and the coordinator of the investigation can coordinate or delegate responsibility for updating a development version of the PRD. Once the cause of the anomaly or anomalies is understood and a fix has been identified and verified, then integration into the operational PRD can be completed rapidly with all of the appropriate documentation, notification and checkout.

4.3 HST Ground and Flight System Upgrades

Keeping functionality between the spacecraft and the operational ground system is a monumental task in itself and it is for this reason that Data Base Management at a Project level has been essential. In the current system, reference data is organized into files with file management being the responsibility of the Project Data Base office. Each subsystem (PASS, PORTS, etc.) is responsible for managing their own unique set of parameters. There are several types of inputs which may be received by the PDB Office as requests for update, each varying in complexity depending on the nature of the change.

The new concept is for singular, independent data base updates involving revised sensor calibration, software modifications or fine tuning of system control parameters. Under these circumstances, ownership of attributes are spanned between single owner, active and passive users within the ground system element. Each owner-user works in the development area of their ground system element and is responsible for entering the reference data changes, testing and certifying the changes, scheduling the integration into the operational PRD over the wide area network, notifying all users of the update, assuring operations are not adversely impacted and assuring PRD documentation is completed. Any ground system element that uses the files involved in the update will be responsible for incorporating the revision in a timely fashion.

For updates that involves passive users in other ground system elements, coordination by the owner must begin with work in the development area. This will include distribution of the updated files and coordination of the checkout activities with each ground system element involved. The operational checkout will have to be coordinated by the owner as well as active and passive users. As with the independent data base update, the owner is responsible for entering and certifying the changes, scheduling all phases of the checkout and integration into the operational PRD, notifying all users and completing all documentation.

Flight system upgrades involve longer development times and may span all or none of the ground system elements. Therefore work in the Flight system development area must be in parallel nominal up dates of ground system elements. To support parallel development the capability to efficiently merge two versions of the same file will be required of the PRD. Coordination of these development and integration activities will emanate from the Flight Computer System element. The coordination of simultaneous development on different PRD updates by different owners in different ground system elements is not envisioned as being a problem as long as the communication is clear and file/update labeling standards are well defined.

4.4 Servicing Mission Support

Upgrades for servicing mission support can involve developing multiple versions of reference databases simultaneous over extended periods of time. These upgrades have more than the usual flight to ground element combination but may be burden with combinations formed by the inclusion of new equipment or instruments. They may also contain elaborate implementation schedules involving the actual implementation of more than one version and any number of contingencies. As with the flight system upgrade, this is a case requiring concise communication, rigid implementation coupled with good bookkeeping. It involves incorporating organizations which will not be familiar with the PRD system and thus will have to work through one or more of the ground system elements. This scenario will serve as a test how fast a ground system update can be implemented.

4.5 HST Trend Analysis

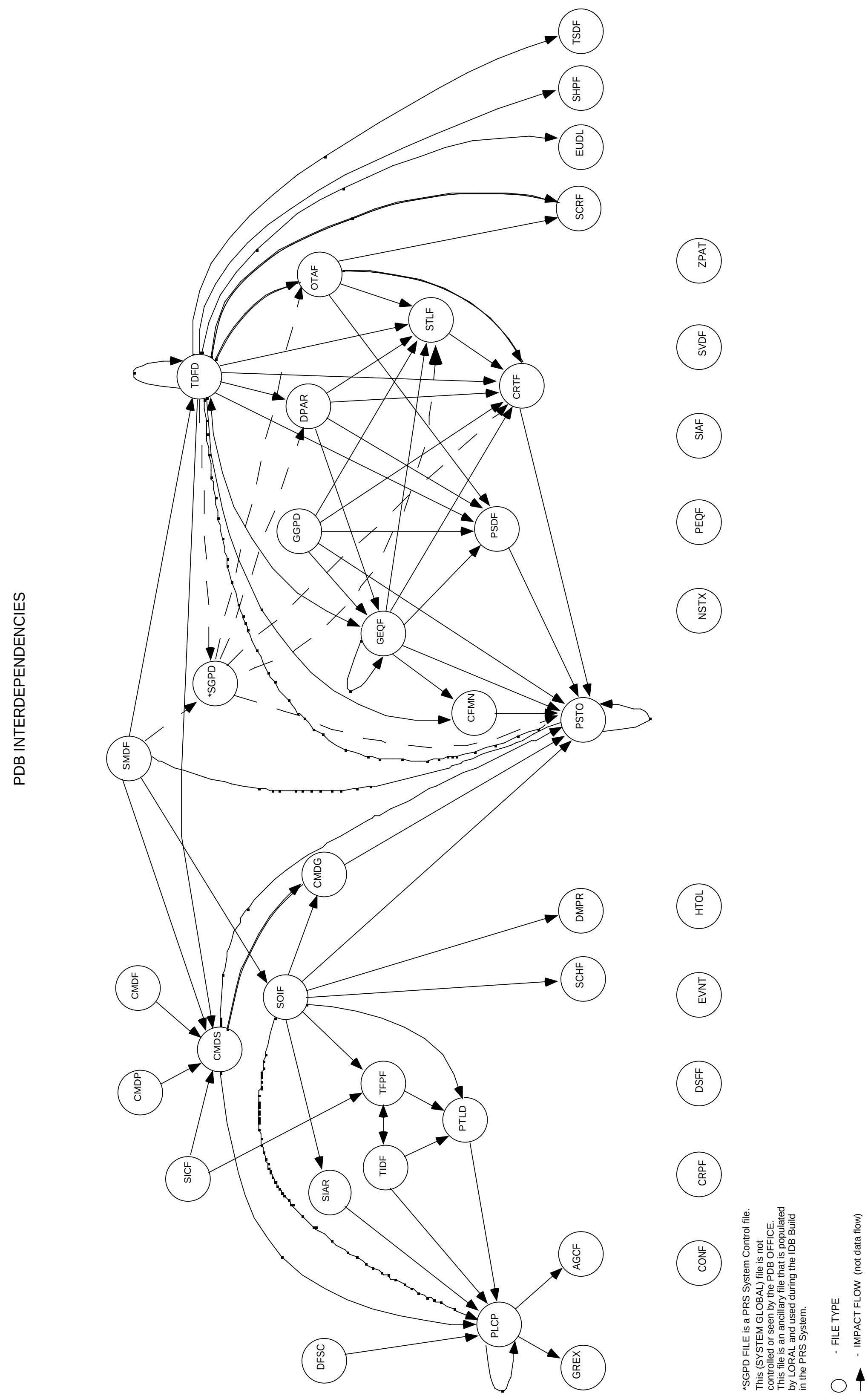
It is important to periodically review subsystem data to determine if there are any differences in the performance of a device or if a flight software environment has changed over some period of time. Trending, whether long or short term gives a comprehensive picture of the spacecraft and subsystem conditions. It is important at this juncture to not only monitor well but to archive important parameters in a time structured log or file to confer with at a later time. For analysis and for historical purposes, a long term archive will be available. Through a menu driven system on the wide area network the user will specify the data and the time frame of interest and the system will automatically access current ground system element databases and/or the data archive to retrieve the data requested for viewing, printing or copying to disk.

APPENDICES

A. PDB Data Dependencies

The figure on the following page is meant to graphically portray the complexity and interdependencies among the present PDB data at a file level. Tables are available to itemize this graphical presentation. The tables could be useful to determine the level of granularity where the coupling takes place
and to be the basis for future optimization.

Figure A-1: PDB Interdependencies



B. Allocation of existing PDB files

The following list is a proposed allocation of the existing PDB files into the VISION 2000 decentralized architecture according to product area. The effort was made to minimize PDB file interdependencies across product area boundaries and to assign ownership to the major user.

CCS	P&SS	SDP	FCS
CFMN	AGCF	EUDL	DPAR(PRS-Loral)
CMDG	CONF	SHPF	NSTX(NSSC)
CRTF	CRPF	TSDF(2)	SGPD(PRS-Loral)
DMPR	DFSC		EVNT(DF224)
PST2	GREX		CRT2(PRS-Loral)
GGPD	HTOL		
GEQF	PLCP		
OTAF	PEQF		
PSDF	PTLD		
PSTO	SCHF		
SCRF	SIAF(1)		
SMDF	SIAR		
STLF	SVDF		
CMDP(3)	ZPAT		
CMDS(3)	TSD3(1)		
CMDF(3)	SICF(5)		
TDFD(3,4)	TFPF(5)		
SOIF(3,6)	TIDF(5)		

(1) STScI Science Operation Database (SCIOPSDB) which maintains 64 files for P&S and SDP functions.
(2) This file will be obsolete when the OSS S/W is no longer supported (~Jan96)
(3) Maintained by CC but passively used by P&S
(4) Maintained by CC but passively used by SDP - unknown architecture of AEDP.
(5) Maintained by P&S but passively used by CC - realtime mods to *.TAB loads
(6) Proper maintained might be Flight S/W.

C. Reference Data Sets

The following table lists the basic information required for operation of HST independent of the current organization according to PDB files and historical system responsibilities. In this form, it represents the minimum interdependency possible.

PRD Element	Active User	Passive User
1. Stored Program Commands	2	None
2. Real Time Commands	1	None
3. Flight Software Description	4	1,2,3
4. Constants/Ephemerides	2	4,3
5. HST Operational Procedures	1	None
6. Telemetry Formats	4	1
7. Memory Maps (SPC)	2	1
8. Memory Maps (Code)	4	1
9. SI Calibration Parameters	3	None
10. System Hardware Configuration	1	2,4
11. Operational Rules	1	1 (primarilly)
12. OPS Limits and Constraints (CARD)	1	2,4
13. Communications Access Control	?	1,2,3,4
14. PRD User Interface Documents	?	1,2,3,4
15. Definition of Reference Data/Audit	1,2,3,4	Local
16. System Control Parameters	1,2,3,4	I/F overlaps
17. Calibration Parameters (Limits)	1	3
18. Sensor Calibration Parameters	1	2

User Notation (refer to Figure 1):

1 = Control Center System
2 = Planning & Scheduling System
3 = Science Data Processing System
4 = Flight Computer System

Reference Data Set Definitions

1. SSM Stored Program Commands (SPCs) are commands which are stored within the SSM computer with an associated vehicle time tag and issued as a function of vehicle time. The time tag has a resolution of one second and may be either a relative (delta) time tag or an absolute time tag. The on-board command software issues an SPC when the vehicle time equals, or exceeds by less than one second, the absolute time tag of a command; for relative SPCs, the execution time shall be the previous command issue time plus the delta time.

2. ST realtime commands (RTCs) are commands executed by the SSM DMS immediately after they are received and verified. RTCs may be software commands, discrete hardware commands, or serial digital hardware commands. They are identified by specific operation codes and command formats as discussed in

3 & 18. Self explanatory.

4. Fundamental physical and HST physical constants (ephemeris information is not included in the PRD because each ephemeris is highly time dependent);

5. HST Operational Procedures are those that specify processes for configuring or operating the vehicle. Operational procedures may specify both Contingency and Routine events.

6. The telemetry mux loads are used by the flight software to build the telemetry downlink. They define which telemetry parameters to sample, in what order, and how often to sample them for inclusion in the downlink.

7. & 8. The memory map defines what areas of memory are used for code, constant data, variables, on-board SPC storage, telemetry mux format loads, and FSW code patch areas. Information defining the structure and contents of all DF-224 and NSSC-1 stored-process commands;

9. SI-Calibration Data is the set of time-tagged data used by the Science Data(SD) processing pipeline to calibrate the SD. This data is supplied by the Individual science instrument teams, used in the pipeline processing, and archived in DADS for use in any reprocessing.

10. System Hardware Configuration, for the on-board systems, is the basic (nominal) set-up needed to operate the vehicle and provide Science data. For ground systems the ability to collect and display all data and telemetry output from the vehicle.

11. Operational Rules govern Operational interface Procedures between various elements of HST and the HST vehicle itself.

12. OPS Limits and Constraints --> Command Constraints And Restrictions (CARD). A constraint is "an operational limitation imposed on the use of the hardware that must not be violated in either planning or operations. This includes features or characteristics of the hardware inherent to the design which, if violated, could cause physical damage. A restriction is an operational limitation imposed on the use of the hardware that may be violated if the trade-off between the desired operation and the resulting risk of system degradation is operationally acceptable and authorized by the Mission Operation Manager."

13. Communication Access Control - Information defining:
- a.) who can access the PRD
- b.) who can modify the PRD
- c.) who needs to be notify of changes to the PRD
- d.) how database modifications get incorporated into the PRD
- e.) how database modifications get passed between the PDTs

14. PRD User Interface Standards - Information defining what contents in the Reference Database will be displayed, reported, or electronically transmitted to the users and to the PDTs. Also the PRD User Interface Standards will have information on how the data will be formatted for display, modification, and interface between PDTs.

15. Currently undefined. Will depend upon detailed design of the PRD system.

16. System control parameters used to assure standardized processing within each area and in some cases between areas. For example, this includes information which the PASS mission scheduler and command loads software use to interpret and expand SMS command statements into executable stored-process commands.

17. Calibration Parameters (Limits) for telemetry data can be one of three different types: 1) Bilevel, 2) Multi-level event or 3) Analog. Some of these types have several different calibration subtypes. The calibration describes the general methods used by Ground Test Software to decode data from the bitstream for all calibration types and subtypes.